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PATENT  
0104-0354P

IN THE U.S. PATENT AND TRADEMARK OFFICE

Applicant: William HOLM et al. Conf.: 7653  
Appl. No.: 09/901,592 Group: 1762  
Filed: July 11, 2001 Examiner: UNKNOWN



For: METHOD AND APPARATUS FOR APPLYING  
VISCOUS MEDIUM ONTO A SUBSTRATE

LETTER

Assistant Commissioner for Patents  
Washington, DC 20231

September 19, 2001

Sir:

Under the provisions of 35 U.S.C. § 119 and 37 C.F.R. § 1.55(a), the applicant(s) hereby claim(s) the right of priority based on the following application(s):

<u>Country</u>	<u>Application No.</u>	<u>Filed</u>
SWEDEN	0002619-5	July 11, 2000

A certified copy of the above-noted application(s) is(are) attached hereto.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies, to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fee required under 37 C.F.R. §§ 1.16 or 1.17; particularly, extension of time fees.

Respectfully submitted,

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Attachment

# PRV

PATENT- OCH REGISTRERINGSVERKET  
Patentavdelningen

Group 1762  
09/901,592  
1st  
Birt Stewart et al.  
(703) 205-8000  
Att. docket 0104-0354P

## Intyg Certificate

Härmed intygas att bifogade kopior överensstämmer med de handlingar som ursprungligen ingivits till Patent- och registreringsverket i nedannämnda ansökan.

This is to certify that the annexed is a true copy of the documents as originally filed with the Patent- and Registration Office in connection with the following patent application.

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METHOD, APPARATUS AND USETechnical field of the invention

The present invention generally relates to the field of providing substrates with viscous medium. More specifically, the invention relates to a method of applying a viscous medium on a substrate, said method comprising the step of screen printing predetermined amounts of the viscous medium on predetermined positions on the substrate; an apparatus for application of a viscous medium onto a substrate, said apparatus comprising screen printing means for screen printing predetermined amounts of the viscous medium on predetermined positions on the substrate; and an apparatus for application of additional viscous medium onto a screen printed substrate.

15 Background of the invention

The most common method of applying viscous medium, such as solder paste, to a substrate, such as a PCB, in electronics production is by using screen printing. The vast majority of viscous medium deposits can be applied by this method. However, in specific circumstances there is a need for different viscous mediums at different locations on the substrate. This poses a problem, since it is very difficult, and presents a number of difficulties to be overcome, to add viscous medium by performing an extra screen printing procedure, after an initial application of viscous medium. Further, it is sometimes desired to produce patterns of viscous medium that are very difficult to achieve through screen printing, such as the pattern of an unfilled circle.

30 It can also be desired that the applied viscous medium presents different heights at different positions on the substrate in order to accommodate, e.g., chip components having different heights, or components having dif-

ferent lead angle accuracy. A solution to the latter problem that has been suggested in the art is to use so called stepped stencils for the screen printing. However, these stencils present a number of drawbacks that have  
5 prevented widespread use of this solution.

Also, the application of very small deposits, primarily circular, i.e. dots, of viscous medium is not possible to obtain through screen printing, since the adhesion forces from the stencil would become too great in  
10 comparison to the adhesion forces from the substrate. As a consequence, very small deposits would attach to and follow the stencil when the stencil is removed. It could be imagined that this problem is overcome by using a thinner stencil. However, that would have undesired draw-  
15 backs in that it would result in an overall decrease of the height of the deposits, and thus the overall volume, which is undesired and would pose a problem for larger deposits.

According to the state of the art, efforts have been  
20 made to solve the above stated problems by using a conventional dispensing equipment. By using a conventional dispenser it is possible to add viscous medium following an initial screen printing of the substrate for producing said patterns of viscous medium that are not easily  
25 achieved through screen printing. With a conventional dispenser it can also be possible to apply viscous medium having different height at different locations on the board. However, the conventional dispensers have a number of disadvantages. The process of conventional dispensing  
30 of viscous medium is relatively slow, and the application of very small deposits of viscous medium through conventional dispensing is difficult.

#### Summary of the invention

35 Thus, an object of the present invention is to provide a solution to the above stated problems in relation to the application of additional viscous medium to a sub-

strate that already has been subject to initial application of viscous medium through screen printing.

This and other objects are achieved according to the present invention by providing a method, an apparatus,  
5 and an apparatus having the features defined in the independent claims. Preferred embodiments are defined in the dependent claims.

According to a first aspect of the invention, there is provided a method of applying viscous medium on a substrate, comprising the steps of screen printing predetermined amounts of the viscous medium on predetermined positions on the substrate, and add-on jetting of predetermined additional amounts of viscous medium on predetermined positions on the screen printed substrate.  
10

According to a second aspect of the invention, there is provided an apparatus for application of a viscous medium onto a substrate, comprising screen printing means for screen printing predetermined amounts of the viscous medium on predetermined positions on the substrate, and  
15 jetting means for jetting predetermined additional amounts of viscous medium on predetermined positions on the screen printed substrate.  
20

According to a third aspect of the invention, there is provided an apparatus for application of additional viscous medium onto a screen printed substrate, comprising jetting means for jetting said additional amounts of viscous medium on predetermined positions on the substrate.  
25

According to a fourth aspect of the invention, there is provided use of screen printing and subsequent jetting for applying a viscous medium on a substrate.  
30

According to a fifth aspect of the invention, there is provided use of viscous medium jetting for applying additional viscous medium on a screen printed substrate.  
35

For the purposes of this application, it is to be noted that the term "viscous medium" should be interpreted as solder paste, flux, adhesive, conductive adhesive.

sive, or any other kind of medium used for fastening components on a substrate, or resistive paste; and that the term "substrate" should be interpreted as a printed circuit board (PCB), a substrate for ball grid arrays (BGA),  
5 chip scale packages (CSP), quad flat packages (QFP), and flip-chips or the like. It is also to be noted that the term "jetting" should be interpreted as a non-contact dispensing process that utilises a fluid jet to form and shoot droplets of a viscous medium from a jet nozzle onto  
10 a substrate, e.g. as described in the published International Application WO 99/64167, as compared to a contact dispensing process, such as "fluid wetting", which is the act of the viscous medium leaving the dispense tip, contacting and clinging to the substrate and remaining on  
15 the substrate as the dispense tip pulls away. Further, the term "add-on" refers herein to the application of additional viscous medium, i.e. not the initial application.

Thus, the present invention is based on the advantageous idea of using add-on jetting for the application of  
20 additional viscous medium onto a substrate onto which viscous medium previously has been applied through screen printing.

The use of jetting overcomes a number of the above  
25 stated problems relating to screen printing. First, jetting enables the application of viscous medium of a different type or sort than what has been initially applied. The use of jetting also enables the application of viscous medium in any desired pattern, which is not possible  
30 through screen printing. The application of viscous medium of varying height is also achievable through jetting. Also, jetting is advantageous to conventional dispensing in that it is faster, more accurate, and more flexible. In fact, the use of conventional dispensing often  
35 provide a bottle neck that increases the cycle time in the overall component mounting process, as compared to the use of jetting. It has also been found that it is

possible to achieve smaller dots when using jetting than when using conventional dispensing.

Further, one of the main advantages obtained by using jetting for applying additional viscous medium onto a screen printed substrate, is that it is possible to apply viscous medium at positions where viscous medium already has been applied. Thereby, it will be possible to easily increase the height of the applied viscous medium at a specific location without any danger of the nozzle of the jetting device being smeared by the viscous medium already applied on the substrate.

According to a specific embodiment of the present invention, the results of the application of viscous medium onto the substrate is inspected, errors of the application is determined based on said inspection, and at least some of said errors are corrected, wherein said correction comprises jetting of additional viscous medium onto the substrate. This means that not only the predetermined additional amounts of viscous medium is applied onto the substrate through jetting, but also any additional amount of viscous medium that is determined to be required as a result of errors in the regular viscous medium application.

Said inspection can be performed between the screen printing and the add-on jetting of viscous medium, following the add-on jetting of viscous medium, or both. If the inspection is performed between the screen printing and the add-on jetting, the predetermined add-on jetting can be combined with the correction jetting, either by determining the positions where jetting is required and the amount, or by performing the add-on jetting and the jetting correction in sequence.

Preferably, a single jetting means performs both the add-on jetting and the jetting correction, which decreases the physical complexity of the system. Alternatively, this is performed by separate jetting means.

When the inspection is performed following the add-on jetting only, the correction can be performed in a separate machine. This decreases the cycle time for the overall viscous medium application process, but increases  
5 the line length. If a separate machine is used for the jetting correction, the inspection, evaluation and determination of errors is preferably, but not necessarily, performed in the same machine.

According to a further embodiment of the invention,  
10 the correction of applied viscous medium also comprises the removal of surplus viscous medium. Preferably, this is performed at specific locations on the substrate only, at which the inspection has revealed that too much viscous medium has been applied. This can refer to the  
15 amount of viscous medium for a given location, the height of the applied viscous medium, the applied viscous medium being offset from the intended position, or that viscous medium has been applied at a position where it was not supposed to.

20 It should be noted that the screen printing and the subsequent jetting of viscous medium is for the purposes of this application not limited to the use of one viscous medium for both the screen printing and the jetting. Consequently, a number of different types and sorts of viscous medium can be used. For instance, the screen printing  
25 is performed for a viscous medium, then add-on jetting of another viscous medium is performed. Additionally, the subsequent jetting, the add-on jetting and/or the correction jetting, can be performed in sequences  
30 with different sorts of viscous medium. Then, more than one jetting means is preferably used to avoid unwanted mixing of the different viscous medium and/or to avoid increased cycle time due to change of the viscous medium supply and possible cleaning of the jetting means.

35 The above mentioned and other aspects, advantages, and features of the invention will be more fully under-



stood from the following description of exemplifying embodiments thereof.

Brief description of the drawings

5 Exemplifying embodiments of the invention will be described below with reference to the accompanying drawings, in which:

Figs 1-3 are block diagrams illustrating arrangements according to alternative embodiments of the present invention.

10 Figs 4-6 illustrate in flow chart form the alternative embodiments shown in Figs 1-3.

Detailed description of preferred embodiments

15 In the block diagrams of Figs 1-3, the thick-lined arrows depict the movement of a substrate 1 through the production line. The dashed boxes simply indicate that the means or apparatus depicted within the box can be incorporated in a single machine.

20 With reference to Figs 1-6, there is illustrated exemplary embodiments of the present invention. As to the specific means used for screen printing, jetting, inspection of application results, removing solder paste, and component mounting, use can be made of means which by themselves are known within the art, and the constructional features of which are also known. Therefore, detailed constructional and functional description of each separate means have been omitted. Furthermore, the viscous medium of the description of exemplary embodiments below is solder paste. However, the invention is not restricted to using solder paste. On the contrary, any type of viscous medium can be used.

Turning first to Figs 1 and 4, there is shown a first exemplary embodiment of the present invention. A substrate 1 is at step 100 transferred to a screen printer 12 where an initial application of solder paste is performed, at step 102. Then, the substrate 1 is

transferred at step 104 to a machine 16 for performing add-on jetting of additional amounts of solder paste, at step 106. The amounts, patterns, heights, type of solder paste, etc., that is added onto the substrate 1 is predetermined. Thus, there is no inspection if the screen printing results performed prior to the jetting of additional solder paste. Following the add-on jetting step, the substrate 1 is at step 108 transferred to a component mounting machine 18, where electrical components are mounted on the substrate 1. As an alternative, there can be a step of inspecting the final results of the combined solder paste application, i.e. both the screen printing and the add-on jetting.

With reference now to Figs 2 and 5, there is shown another exemplary embodiment of the present invention. This embodiment also includes inspection means 14 provided for inspection of the screen printing results. Following screen printing at step 202, the substrate is at step 204 transferred to inspection means 14 that performs the inspection at step 206. The results of the inspection is recorded and relayed to the means 16' for performing the add-on jetting. With the information as to the results of said inspection, the jetting means 16' can also perform any required jetting of additional solder paste onto positions on the substrate where insufficient amounts have been applied due to some error in the initial screen printing. Thus, the jetting means 16' is a combined add-on jetting and correction means 16'. Further, according to this embodiment, the add-on jetting and correction means 16' can also comprise means for removing amounts of solder paste from the substrate. According to this embodiment, the removal is performed through suction of the solder paste at the selected position of the substrate.

The inspection means 14 is preferably incorporated in the same machine as the add-on jetting and correction means 16', thus forming a combined inspection and correc-

tion machine 15. Then, the inspection means 14 could be used to inspect the result of the add-on jetting to further minimise the application errors on the substrate.

However, the inspection means 14 can naturally also be a  
5 separate machine.

Following the correction and add-on jetting, at step 208, the substrate is transferred to the component mounting machine 18, at step 210.

Finally, the block diagram of Fig. 3 and the flow  
10 chart of Fig. 6 illustrate yet another exemplary embodiment of the present invention. Here, the screen printer 12 and the inspection means 14 is incorporated in a single machine 10. Following the screen printing of the substrate 1 and the subsequent inspection of the screen  
15 printing results in the screen printer and inspection means 10, at steps 300-304, the substrate 1 is transferred to an add-on jetting and correction means 16'. The add-on jetting and correction means 16' have the similar features as do the corresponding means 16' of Fig. 2.  
20 When the substrate enters the add-on jetting and correction means 16', said means 16' has received information as to the required corrections, if any, to be performed on the substrate 1. The additional solder paste is then added and any application errors corrected, at step 308,  
25 and the substrate 1 is transferred at step 310 to the component mounting machine 18.

As is understood by the man skilled in the art, the above-mentioned steps would require a certain amount of processing, transferring and evaluating information.

30 This, however, can be performed by conventional processing means which is not shown or further described.

Even though the invention has been described above using exemplifying embodiments thereof, alterations, modifications and combinations thereof, as understood by  
35 those skilled in the art, may be made within the scope of the invention, which is defined by the accompanying claims.

CLAIMS

1. A method of applying a viscous medium on a sub-  
 5 strate, comprising the steps of  
     screen printing predetermined amounts of the viscous  
     medium on predetermined positions on the substrate, and  
     add-on jetting of predetermined additional amounts  
     of viscous medium on predetermined positions on the  
 10 screen printed substrate.

2. The method according to claim 1, comprising the  
 steps of  
     inspecting the results of said screen printing and  
 15 add-on jetting,  
     determining errors of said screen printing and add-  
     on jetting based on said inspection, and  
     correcting at least some of said errors, wherein  
     said correction comprises supplemental jetting of addi-  
 20 tional viscous medium onto the screen printed substrate.

3. The method according to claim 1, comprising the  
 steps of  
     inspecting the results of said screen printing prior  
 25 to said add-on jetting,  
     determining errors of said screen printing based on  
     said inspection,  
     correcting at least some of said errors, wherein  
     said correcting comprises supplemental jetting of addi-  
 30 tional viscous medium onto the screen printed substrate.

4. The method according to claim 3, wherein said  
 supplemental jetting is performed in connection with per-  
 forming said add-on jetting.

35

5. The method according to any one of claims 2-4, wherein said add-on jetting and said supplemental jetting is performed by the same jetting means.

5        6. The method according to any one of claims 2-5, wherein said step of correcting comprises the step of, removing amounts of viscous medium from positions on the substrate.

10       7. The method according to any one of the preceding claims, wherein at least one viscous medium applied through said add-on jetting is different from the viscous medium applied through screen printing.

15       8. An apparatus for application of a viscous medium onto a substrate, comprising screen printing means for screen printing predetermined amounts of the viscous medium on predetermined positions on the substrate, and  
20       jetting means for jetting predetermined additional amounts of viscous medium on predetermined positions on the screen printed substrate.

25       9. The apparatus according to claim 8, comprising inspection means for inspecting the results of said screen printing and jetting, processing means for determining errors of said screen printing and jetting based on said inspection, and  
30       correction means for correcting at least some of said errors, wherein said correction means comprises jetting means arranged for supplemental jetting of amounts of viscous medium onto the screen printed substrate.

35       10. The apparatus according to claim 8, comprising inspection means for inspecting the results of said screen printing,

processing means for determining errors of said screen printing based on said inspection, and

correction means for correcting at least some of said errors, wherein said correction means comprises jetting means arranged for supplemental jetting of amounts of viscous medium onto the screen printed substrate.

11. The apparatus according to claim 9 or 10, wherein the correction means comprises removing means for removing viscous medium from the screen printed substrate.

12. The apparatus according to any one of claims 9-11, wherein the jetting means for jetting additional amounts of viscous medium on predetermined positions on the substrate and the supplemental jetting means is the same jetting means.

13. An apparatus for application of additional viscous medium onto a screen printed substrate, comprising jetting means for jetting said additional amounts of viscous medium on predetermined positions on the substrate.

14. The apparatus according to claim 13, comprising inspection means for inspecting the results of said screen printing and jetting, processing means for determining errors of said screen printing and jetting based on said inspection, and correction means for correcting at least some of said errors, wherein said correction means comprises jetting means arranged for supplemental jetting of amounts of viscous medium onto the screen printed substrate.

15. The apparatus according to claim 13, comprising inspection means for inspecting the results of said screen printing,

processing means for determining errors of said screen printing based on said inspection, and

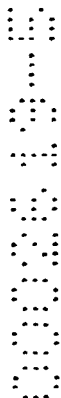
correction means for correcting at least some of said errors, wherein said correction means comprises jetting means arranged for supplemental jetting of amounts of viscous medium onto the screen printed substrate.

16. The apparatus according to claim 14 or 15, wherein the correction means comprises removing means for removing viscous medium from the screen printed substrate.

17. The apparatus according to any one of claims 14-16, wherein the jetting means for jetting additional amounts of viscous medium on predetermined positions on the substrate and the supplemental jetting means is the same jetting means.

18. Use of screen printing and subsequent jetting for applying a viscous medium on a substrate.

19. Use of viscous medium jetting for applying additional viscous medium on a screen printed substrate.



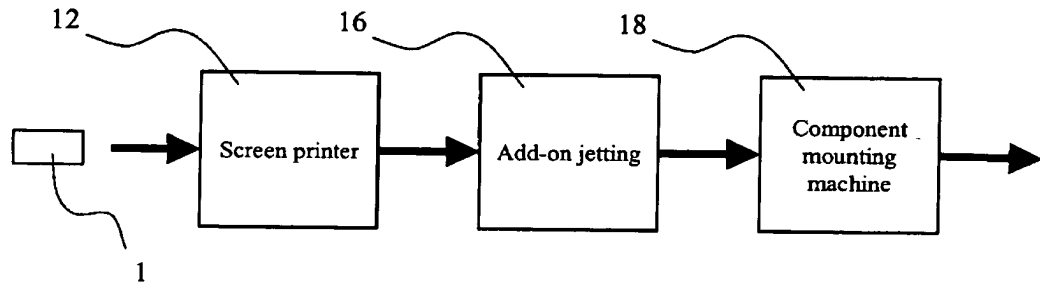
ABSTRACT

The invention relates to the screen printing of vis-  
 5 cous medium onto a substrate and the subsequent applica-  
 tion of additional viscous medium through jetting.

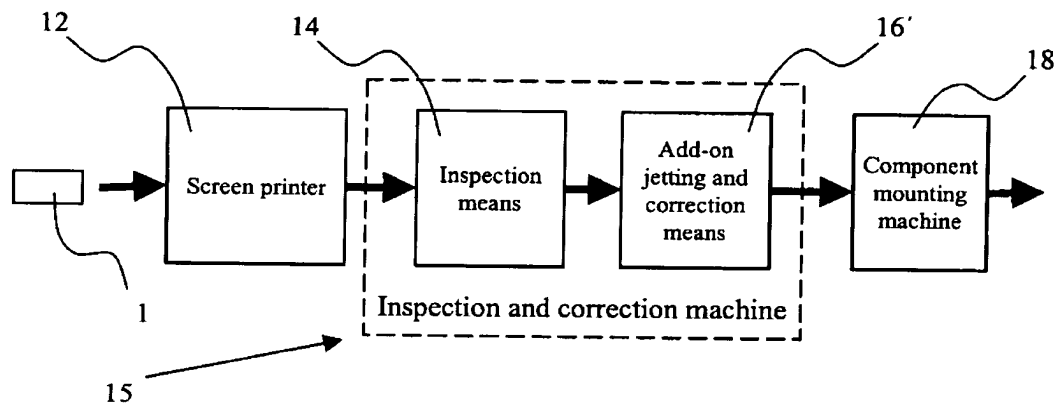
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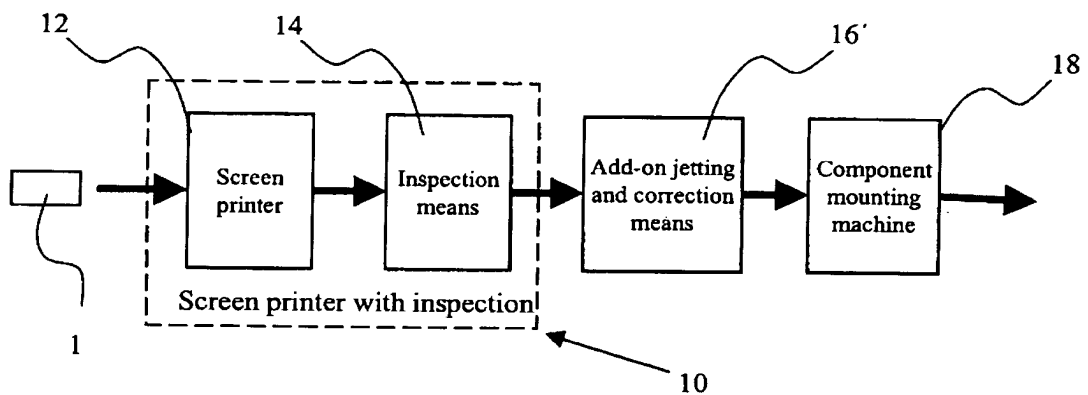
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**Fig. 1**



**Fig. 2**



**Fig. 3**

2/3

Fig. 4

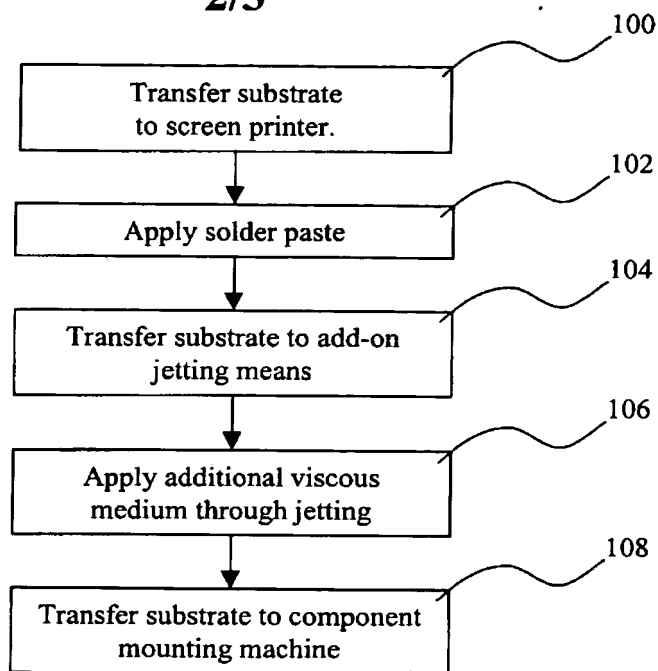
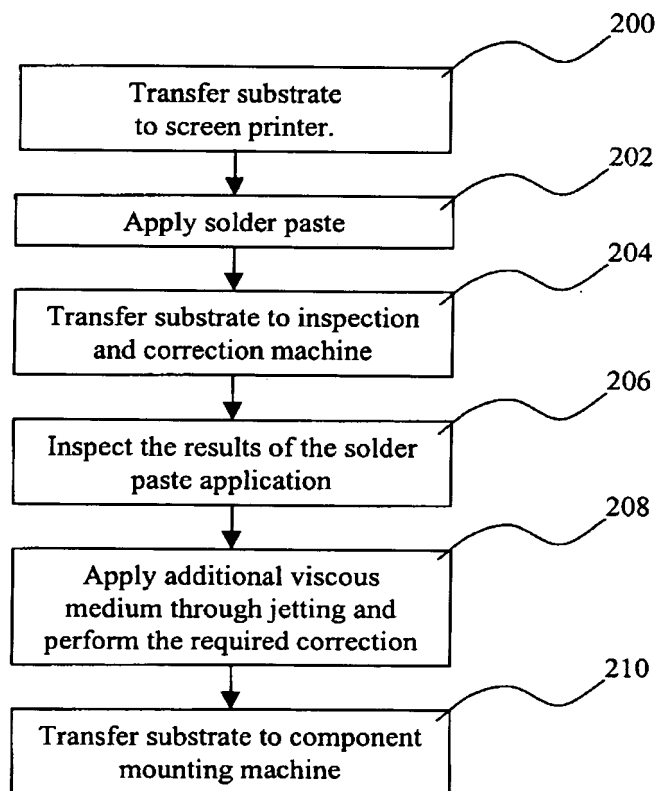
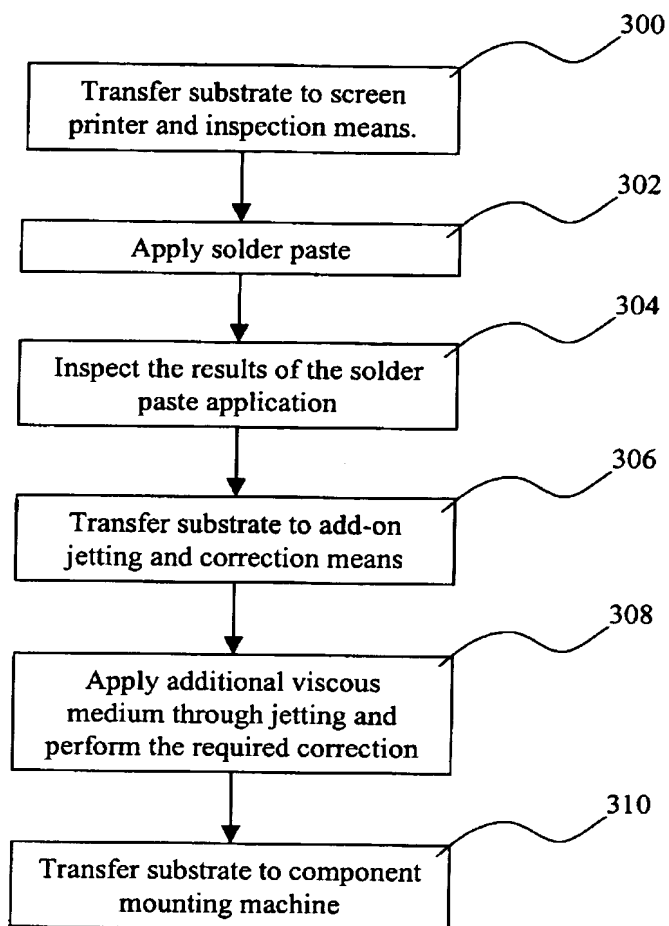


Fig. 5



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**Fig. 6**